

# Connectivity Solutions for the Industrial Internet of Things (IIoT)

## Class 2: Wired Options

May 21, 2019  
Louis W. Giokas

# This Week's Agenda

Monday

IIoT Landscape

Tuesday

Wired Options

Wednesday

Wireless Options

Thursday

Architectures for Individual Plants

Friday

Distributed Operations and External Connections

# Course Description

The Industrial Internet of Things (IIoT) consists of components and systems that interconnect industrial equipment together and, potentially with external systems. These are distributed systems that may span a great area inside a particular facility, and may interconnect facilities. In addition, external systems are typically added to the mix to facilitate control and analysis of the data. In this course we will look at the components, primarily communications, and how they are interconnected and architected.

# Today's Agenda

- Overview
- Communication Protocols
- Automation Protocols
- Wiring Considerations
- Conclusion/Next Class

# Overview

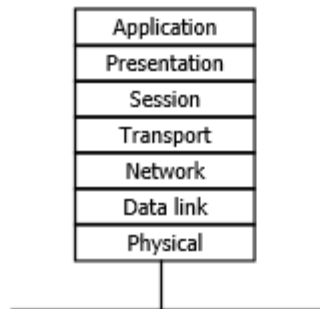
- In this class and the next we will go over the types of interconnections and protocols used in the IIoT environment
- We will start with communication (lower level) protocols
- Next we will discuss higher level protocols used to develop automation applications
- Finally we will look at the actual wiring

# Overview

- Industry Driven
  - The protocols and communication networks used in an industrial context are often driven by vendors of control equipment
  - In other cases, industry consortiums are the drivers (e.g., power industry)
    - Often results from the need for regulatory approval
  - More open standards are making themselves felt as automation becomes more diverse

# Communication Protocols

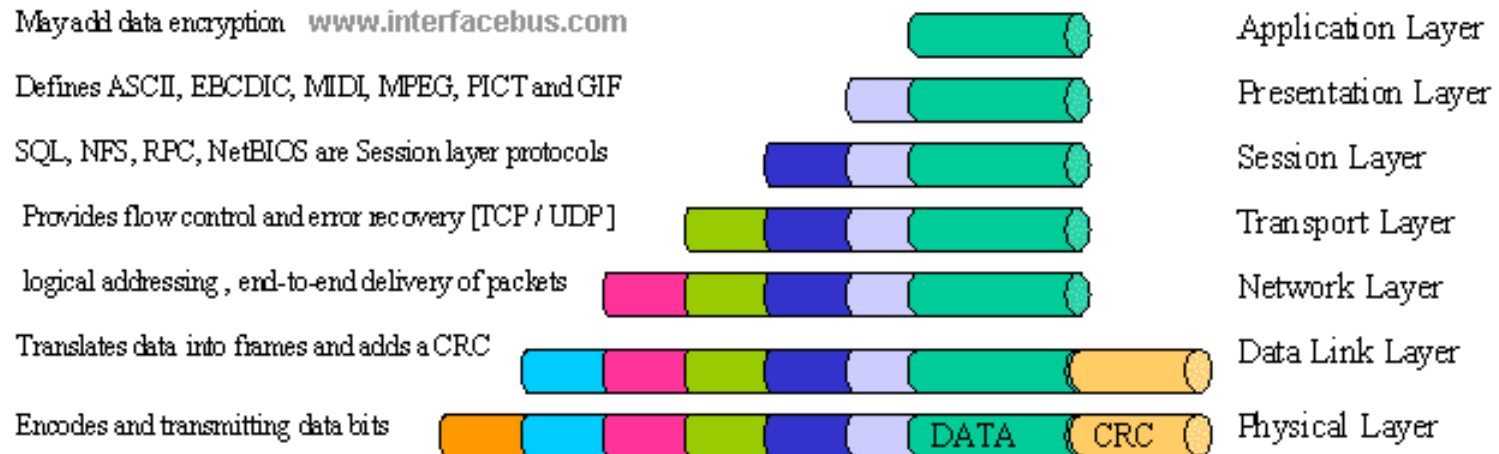
- We use as a reference the ISO (International Standards Organization) OSI (Open Systems Interconnect) Model



ISO: the International Standards Organization  
OSI: Open Systems Interconnection Reference Model (1984)

# Communication Protocols

- Another way to look at this is to see how the data packets are created and consumed at each level





# Communication Protocols

- Many of the protocols we will discuss will be at the transport level and below
- The basic requirements of reliability and real time control preclude the direct use of protocols used for standard communication
- Older, directly wired protocols can still be used, for simpler devices

# Communication Protocols

- Fieldbus (IEC 61158)
  - A group of protocols
  - Many different types of connections
  - Examples
    - EtherCAT
    - Modbus
    - Profibus
    - Interbus (serial)

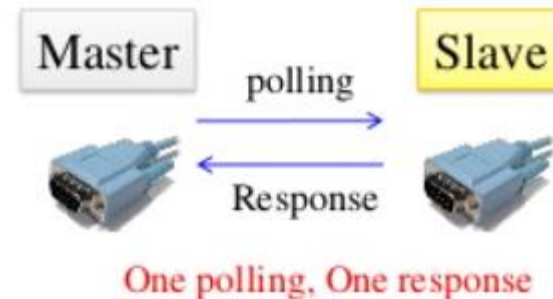
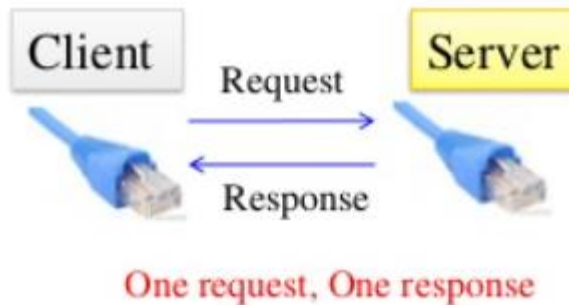
# Communication Protocols

- Modbus
  - Originally designed as a serial protocol for PLCs
  - Master/Slave architecture
  - Open source
  - Robust
  - Simple
  - Flexible

# Communication Protocols

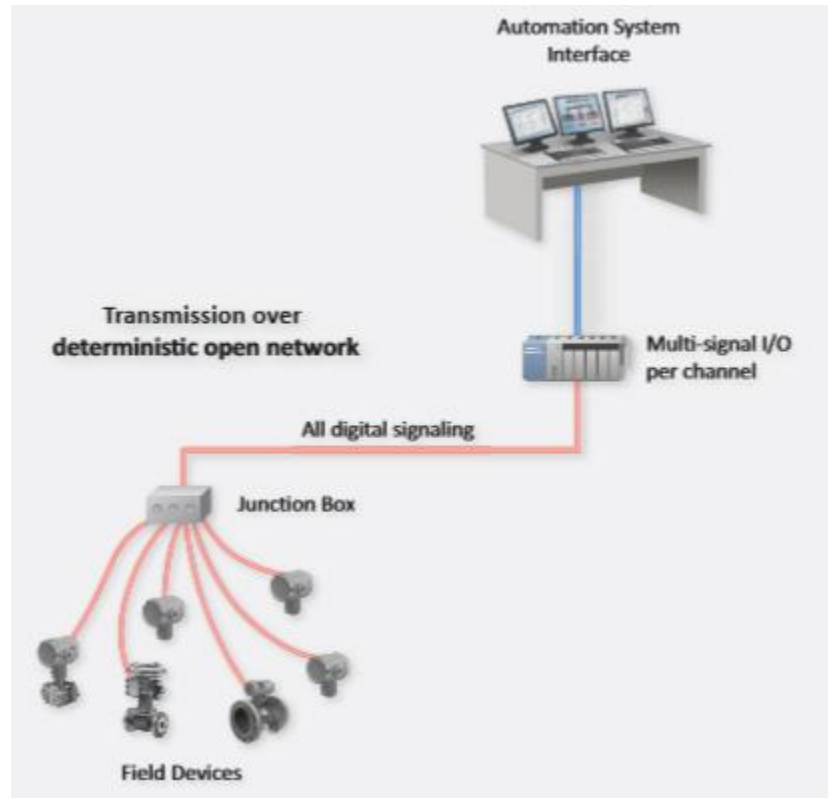
	Modbus TCP	Modbus RTU	Modbus ASCII
Interface	TCP/IP	Serial	Serial
Command type	Hexadecimal (base 16)	Hexadecimal (base 16)	ASCII (base 256)

- **Communication : Query–Response Cycle**
- **Client/Server vs. Master/Slave**



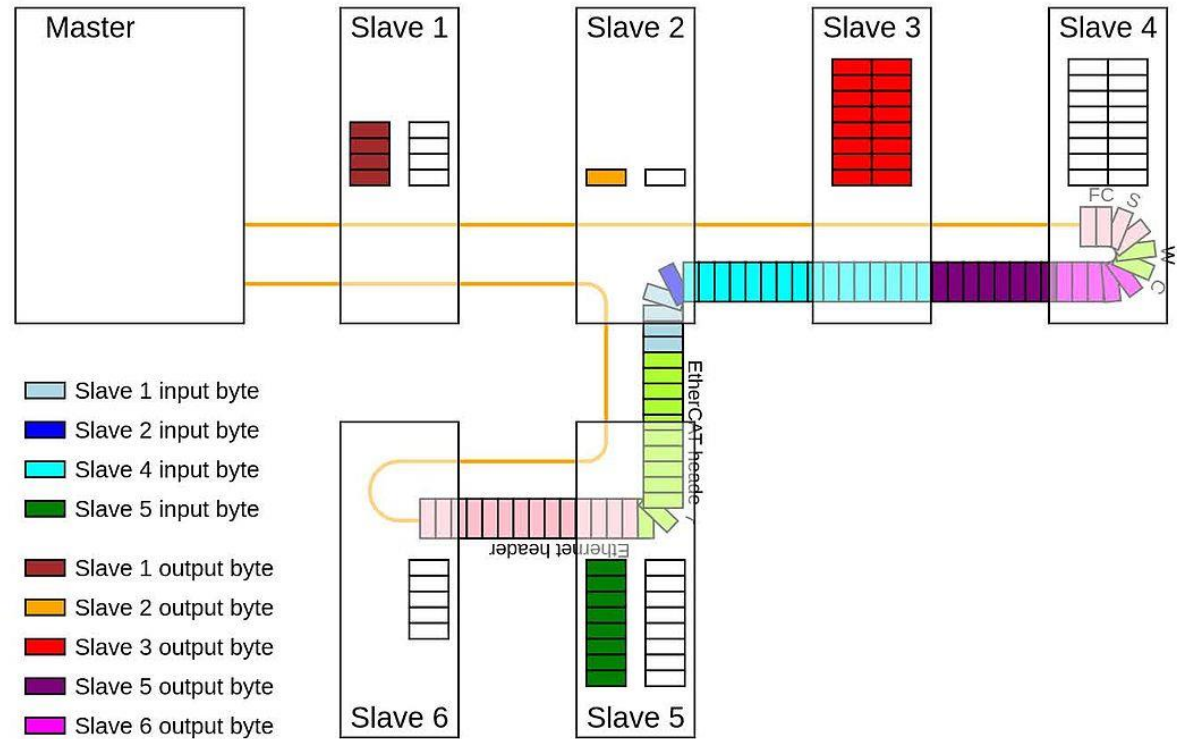
# Communication Protocols

- Fieldbus



# Communication Protocols

- EtherCAT



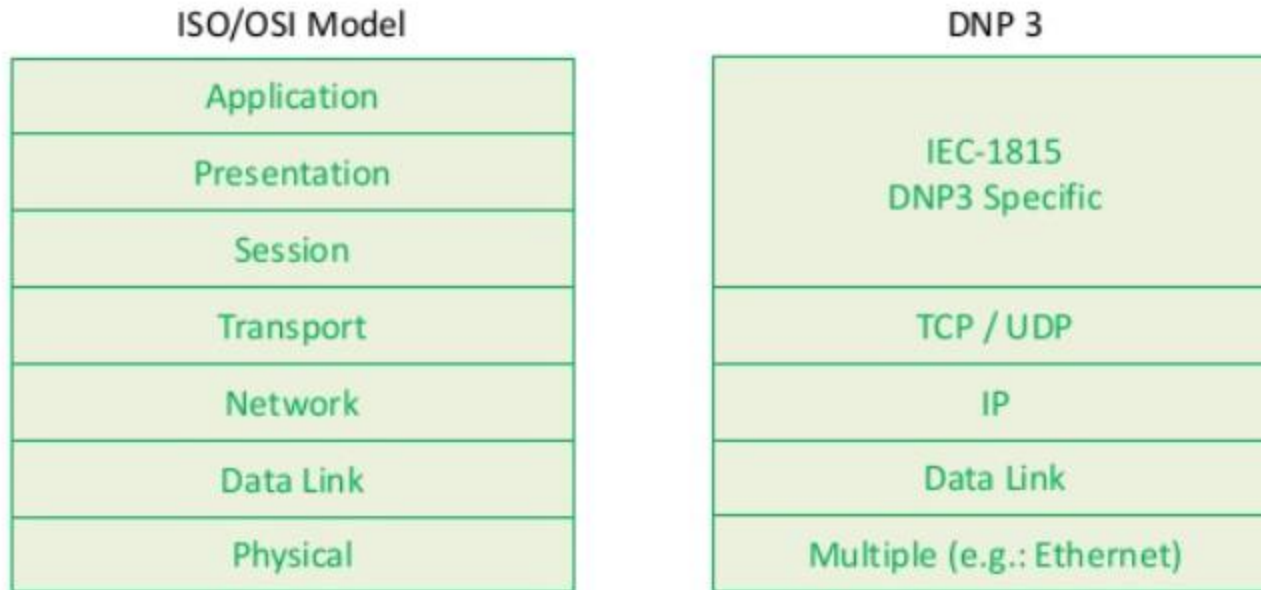
# Communication Protocols

- Utility Protocols
  - Generally different from those used in other applications
    - A good example of an industry specific protocol
  - Specifically geared toward SCADA (Supervisory Control and Data Acquisition) applications
    - Robustness, Efficiency, Interoperability
    - Can be more complex than some other protocols
    - Security
  - Used in both electric and water systems

# Communication Protocols

Master/Slave protocol

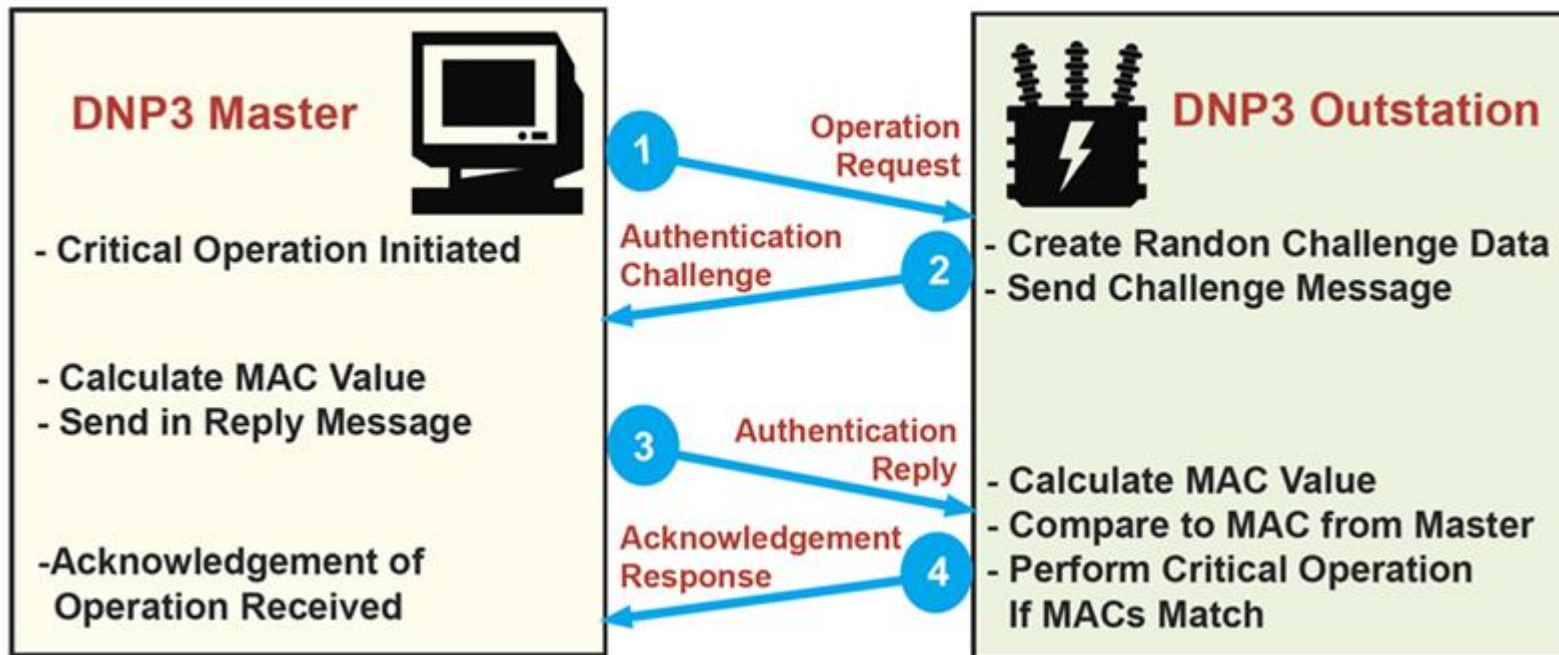
ISO/OSI mapping:





# Communication Protocols

- Authentication and security



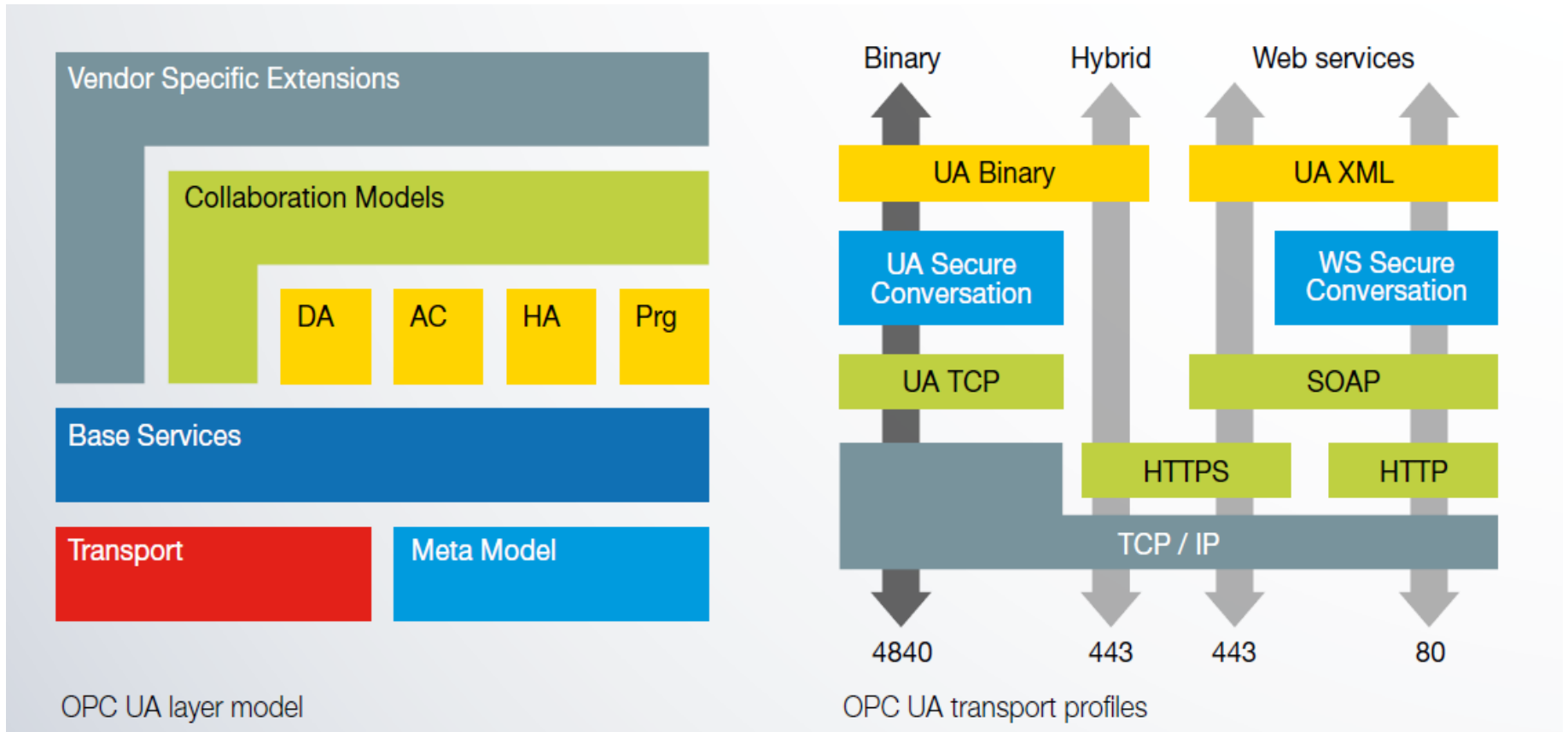
# Automation Protocols

- Automation Protocols are standards that facilitate the creation of industrial control applications
- They consist of programming models (objects) that can be applied to standardize application development
- Ensure smooth integration of all elements of an automation application
  - Integrate with communication protocols

# Automation Protocols

- We will look briefly at OPC (Open Platform Communications)
  - Supported by many vendors
  - A series of standards
  - Links applications to process control automation equipment
  - Originally based on OLE (Object Linking and Embedding) and other standards from Microsoft

# Automation Protocols



# Wiring Considerations

- Many different wiring systems are used in industrial applications
  - Some are standard, some specific to industrial standards and protocols
  - Many are vendor specific
- Both fiber and wire are used
- Connectors may be specific to the application as well

# Wiring Considerations

- Ethernet based standards are becoming common
  - Standard connectors
  - Standard cable
  - Wire and fiber available
  - Long distance operation with minimal noise or interference
  - Easy integration with other in-plant systems

# Conclusion/Next Class

- Today we discussed a range of topics in the area of wired communications for industrial applications
- Many of the protocol stacks we discussed can also include wireless transport, which we will discuss tomorrow